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Indian Standard

METHODS OF MEASUREMENT ON RECEIVERS FOR TELEVISION BROADCAST TRANSMISSIONS

PART 9 ELECTRICAL AND ACOUSTIC MEASUREMENTS AT AUDIO FREQUENCY

(First Revision)

UDC 621·397·62 : 621·317·34 : 534·86 : 621·3·029·4

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METHODS OF MEASUREMENT ON RECEIVERS FOR TELEVISION BROADCAST TRANSMISSIONS

PART 9 ELECTRICAL AND ACOUSTIC MEASUREMENTS AT AUDIO FREQUENCY

(First Revision)

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METHODS OF MEASUREMENT ON RECEIVERS FOR TELEVISION BROADCAST TRANSMISSIONS

PART 9 ELECTRICAL AND ACOUSTIC MEASUREMENTS AT AUDIO FREQUENCY

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part 9) (First Revision) was adopted by the Indian Standards Institution on 6 December 1983, after the draft finalized by the Radio Communications Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The first version of IS : 4545 covered the methods of measurement for television broadcast receivers having monochrome vision reception. With the introduction of colour television receivers, this standard is now being revised to make it applicable to receivers designed for both monochrome and colour vision reception and published in a number of parts to deal with different aspects of characteristics of television receivers.

0.3 This standard (Part 9) covers methods for electrical and acoustic measurements at audio frequencies of television receiver. Other parts in the series are:

Part 1 General considerations
Part 2 Tuning properties and general measurements
Part 3 Geometrical properties of the picture
Part 4 Synchronizing quality
Part 5 Sensitivity
Part 6 Selectivity and response to undesired signals
Part 7 Fidelity
Part 8 Compatibility with audio visual recording equipment

0.4 This standard (Part 9) is largely based on IEC Publication 107-2 (1980) 'Recommended methods of measurement on receivers for television broadcast transmissions: Part II Electrical and acoustics measurements at audio-frequencies' issued by the International Electrotechnical Commission.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard (Part 9) covers methods of measurement for electrical and acoustical at audio-frequencies as applied to properties receivers for television broadcast transmissions.

1.2 This part shall be read in conjunction with IS : 4545 (Part 1)-1983*.

2. GENERAL CONDITIONS

2.1 Introduction — Ideally, the measurements of the sound section should be carried out using acoustic techniques. Due to the nature of the measurements and to simplify interpretation of the results, purely electrical measurements are recommended, where possible, since the interpretation of acoustic measurements remains difficult and a subjective aspect is commonly present in their evaluation. All measurements shall, unless otherwise specified, be carried out under the conditions specified in IS : 4545 (Part 1)-1983*. Care shall be taken that no infringement is made of the requirements of **5.1** of IS : 4545 (Part 1)-1983*.

2.2 Environmental Conditions — *See* **4** of IS : 4545 (Part 1)-1983*.

2.3 Precautions During Measurements — *See* 5 of IS : 4545 (Part 1)-1983*.

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*Methods of measurement on receivers for television broadcast transmissions: Part 1 General considerations (*first revision*).

*Methods of measurement on receivers for television broadcast transmissions: Part 1 General considerations (*first revision*).

3. SETTING OF TONE CONTROLS

3.1 Unless otherwise stated, the tone controls shall be set to give the most uniform response over the greatest part of the audio-frequency range. The response referred to, is either the electrical or the acoustic response depending on how the output is prescribed to be measured. The method used shall be stated with the result. Once established, this reference setting shall be designated as the normal setting of the tone controls for all measurements unless the manufacturer has specified another normal setting of the tone controls to be used as a reference.

4. AUDIO-FREQUENCY INPUT SIGNAL

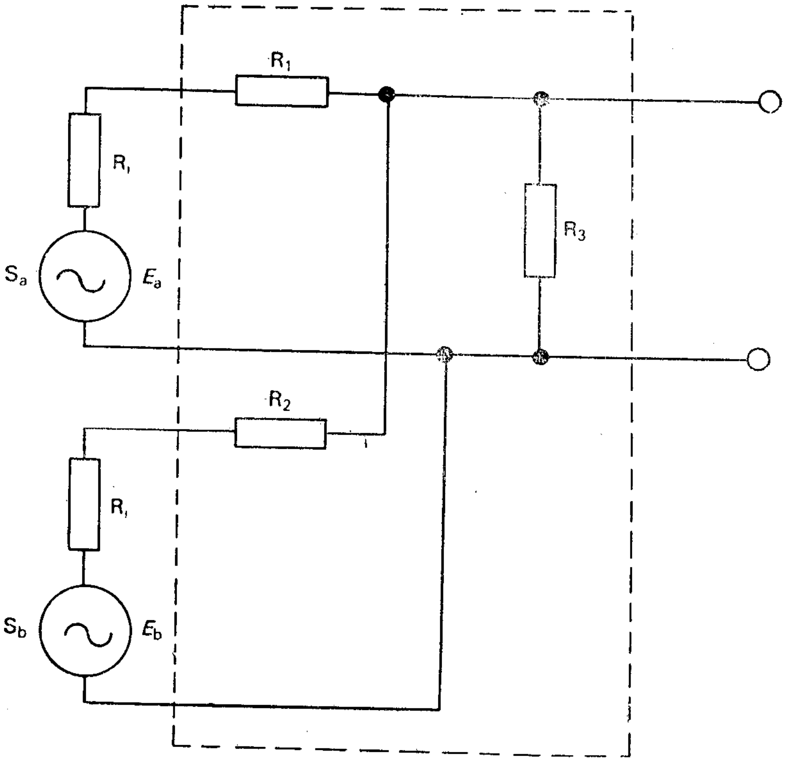
4.1 For the purpose of audio-frequency measurements on television receivers the audio-frequency signal shall be applied in the form of a suitable modulated radio-frequency signal together with the associated picture signal. The audio-frequency signal is defined in terms of its frequency (*see* **4.3** and **4.6**) and its modulation factor (*see* **4.4**).

4.1.1 Unless otherwise stated, the picture modulation shall consist of a mid-grey raster. Some receivers that give satisfactory sound reproduction on normal programme transmissions may operate anomalously giving rise to buzz when operated from certain types of electronically generated test patterns having a wide picture signal spectrum and, or alternatively, strong components at sub-harmonics of the intercarrier frequency. In such cases, precautions must be taken in order that the accuracy of the measurements is not affected. The characteristics of the picture and sound signals, including any audio-frequency pre-emphasis are those defined for the system in use. These signals shall be applied to the radio-frequency input circuit and the receiver tuned to a stated channel in accordance with **7, 8** and **9** of IS : 4545 (Part 1)-1983*. Where the receiver has audio-frequency input or output terminals and is equipped for stereophonic reproduction or for the reproduction of more than one sound channel from a single received transmission, additional measurements shall be made.

NOTE — Considering that television receivers may be used on cabled distribution system having reduced sound carrier levels, it may be useful to make additional measurements at the appropriate levels.

4.2 Combining Networks — When two audio-frequency signals are to be applied simultaneously, suitable combining networks or circuits shall be employed in order to avoid intermodulation in the two signal generators as a result of interaction.

4.2.1 A simple passive network is normally adequate for this purpose. In the example shown in Fig. 1, the generators are connected through



R_1 and R_2 should be equal to or greater than the rated load impedance of the generators S_a and S_b. R_3 is approximately one-tenth of R_1 and R_2 whichever is lower.

FIG. 1 EXAMPLE OF PASSIVE COMBINING NETWORK

series resistors to provide current sources that can be summed in a third resistor of comparatively low value. If required, a matching pad or resistor may be connected between the combining network and the external load.

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*Methods of measurement on receivers for television broadcast transmissions: Part 1 General considerations (*first revision*).

4.3 Standard Reference Frequency — The standard reference frequency for audio-frequency measurements and for adjustment purposes is 1 000 Hz.

4.4 Modulation Factor — The audio-frequency input level shall be expressed in terms of modulation factor of the radio-frequency input signal in the case of sinusoidal modulation:

a) for systems using amplitude modulated sound, the modulation percentage; and

b) for systems using frequency modulated sound, the ratio of the actual frequency deviation to the maximum deviation as defined for the system in use.

4.5 Recommended Audio-Frequencies for Measurements — To facilitate the comparison of results, the selection of audio-frequencies for receivers measurements shall preferably be restricted to a minimum. If a continuous record is not required, measurements shall be made at one of these preferred frequencies. The degree of preference is indicated by the type of printing character shown in Table 1, except that the use of frequencies other than those indicated in Table 1 may be necessary for certain purposes, for example, at frequencies at which anomalies are observed.

4.6 Table of Preferred Frequencies — Table 1 gives a list of preferred frequencies with a ratio of approximately $10^{-0\cdot05}$. The ×'s in the columns indicate the frequencies to be used when the interval is 1, 1/2 or 1/3 octave.

TABLE 1 PREFERRED FREQUENCIES IN HERTZ

Preferred Frequencies	Interval in Octave			Preferred Frequencies	Interval in Octave			Preferred Frequencies	Interval in Octave		
	1	1/2	1/3		1	1/2	1/3		1	1/2	1/3
16	×	×	×	160			×	1 600			×
18				180		×		1 800			
20			×	200			×	**2 000**	×	×	×
22·4		×		224				2 240			
25			×	**250**	×	×	×	2 500			×
28				280				2 800		×	
31·5	×	×	×	315			×	3 150			×
35·5				355		×		3 550			
40			×	400			×	**4 000**	×	×	×
45		×		450				4 500			
50			×	**500**	×	×	×	5 000			×
56				560				5 600		×	
63	×	×	×	630			×	6 300			×
71				710		×		7 100			
80			×	800			×	**8 000**	×	×	×
90		×		900				9 000			
100			×	**1 000**	×	×	×	10 000			×
112				1 120				11 200		×	
125	×	×	×	1 250			×	12 500			×
140				1 400		×		14 000			
160			×	1 600			×	**16 000**	×	×	×

Note 1 — The frequencies in the table have been rounded slightly, for example, 500 is listed instead of 501·187. The maximum error is 1·22 percent.

Note 2 — Misleading results may be obtained if measurements are taken close to line scan frequency.

5. AUDIO-FREQUENCY OUTPUT POWER

5.1 Definition — The audio-frequency output power is the electrical power consumed in the audio-frequency substitute load specified for tests. The following concepts of audio-frequency output power are defined or measured:

Standard output power: *see* **5.4**,
Maximum useful electrical
output power: *see* **5.5**.

5.2 Audio-Frequency Substitute Load — Unless otherwise specified, the audio-frequency substitute load is a resistor of a specified value which is to be substituted for the output transducer or for an audio transmission line of given characteristic impedance, whichever is applicable, when measuring the output power at the relevant terminals. The value of the substitute load is that specified by the manufacturer. Where this value is not available, for a full range signal moving coil loudspeaker of the direct radiator type, the modulus of the lowest value of the electrical impedance in the frequency range above the base resonance of the loudspeaker shall be chosen.

5.3 Audio-Frequency Output Power, Method of Measurement — The audio-frequency substitute load shall be connected to the output circuit of the receiver during the measurement of the output power. The indication on the instrument for measuring the output power shall be based on the measurement of rms values of current or voltage. If necessary, filters shall be introduced into the output meter circuits for the reduction of hum, scan generator, or other interference provided that their attenuation is taken into account in the calibration and provided that the impedance presented to the receiver is maintained in accordance with **5.2**. The output power is expressed in dB (mW), in milliwatts or in watts.

5.4 Standard Output Power — Three different values are recommended as level of standard output power, 500 mW, 50 mW, 5 mW. The corresponding levels are 27 dB (mW), 17 dB (mW), 7 dB (mW), respectively. Where applicable, 50 mW shall be considered as the preferred value. In any case, the value chosen shall be stated with the results. It shall be confirmed that the value chosen is not greater than 10 percent of the maximum useful electrical output power.

5.5 Maximum Useful Electrical Output Power — The maximum useful electrical output power is the lowest value of output power measured according to **5.3** at an audio modulation frequency of 1 000 Hz that gives rise to 10 percent harmonic distortion (*see* **13**).

NOTE 1 — The maximum useful electrical output power may be measured for other frequencies in addition to 1 000 Hz, the frequencies used being indicated with the results.

NOTE 2 — A maximum distortion of 10 percent is considered to be the upper limit, 5 percent or lower may be used alternatively.

5.6 Method of Measurement — The receiver is provided with a radio-frequency input signal and is tuned as described in **4.1**. The tone controls are set in their normal position. The audio-frequency modulating signal, with a frequency of 1 000 Hz, is adjusted for a 30 percent modulation factor.

The setting of the volume control is varied and the harmonic distortion measured as a function of the audio-frequency output power. If required, the measurement may be repeated at other modulating frequencies.

5.7 Presentation of Results — The maximum useful electrical output power is to be recorded together with the frequencies used and the values of distortion at which the measurements are made.

6. ACOUSTIC FREQUENCY RESPONSE CHARACTERISTIC

6.1 Definition — The acoustic frequency response characteristic of a receiver represents the relationship between the sound pressure generated by the output signal at a defined point in free space and a constant audio-modulation level, as a function of the applied frequency.

6.2 Method of Measurement — The receiver is provided with a radio-frequency input signal and is tuned as described in **4.1**. Tone controls are placed in the normal position. The volume control is so adjusted that at an audio-modulation frequency of 1 000 Hz, and a modulation factor of 30 percent, the standard output power is obtained. If the volume control is physiologically weighted (tone compensated), it shall be set for minimum tone compensation effect and the required output power obtained by adjusting the modulation input level. If, at a given frequency within the range of measurements, the electrical or acoustic sections are overdriven, a suitable lower output level should be chosen and the value of this level stated with the measurement results. The modulation frequency within the selected audio-frequency range is varied, maintaining constant the modulation input level.

The measurements should be made on the optical axis of the picture tube at the following distances:

a) 1 m in the case of picture tubes having a diagonal of 48 cm or less, and

b) 2 m in the case of picture tubes having a diagonal exceeding 48 cm.

The sound pressure relative to the pressure at 1 000 Hz is measured. The absolute value of the sound pressure expressed in pascals or the relative value in decibels referred to a pressure of 20 μPa at the reference frequency of 1 000 Hz is to be given with the results.

These measurements should be carried out in free space or in a room fulfilling the requirements that the sound field at the measurement point does not differ at any frequency within the required range from the conditions of free space.

The microphone shall be calibrated in a free sound field so that it indicates the sound pressure that would occur at the measurement location if the microphone and the consequent distortions of the sound field were absent.

6.3 Presentation of Results — The results shall be depicted as a curve. The frequency shall be plotted on the abscissa using a logarithmic scale and the acoustic output level in decibels as the ordinates on a linear scale where the level at 1 000 Hz, as reference level, is defined as 0 dB. The absolute value of the sound pressure at 1 000 Hz shall be stated on the curve. It is recommended that the curve should also show any de-emphasis curve. The modulation factor used is also to be indicated.

A quantitative indication of any effects due to the measurement location is to be included in the results.

7. ACOUSTIC POLAR DIAGRAM

7.1 Definition — The acoustic polar diagram indicates the sound pressure generated by the loudspeakers in the television receiver as a function of direction at a defined distance and frequency.

7.2 Method of Measurement — The measurement is carried out in free space or in a room as described in **6.1**. The receiver is tuned to a signal in a television channel in accordance with **4.1**. The volume control is so adjusted that at a modulation frequency of 1 000 Hz and a modulation factor of 30 percent, the standard output power is obtained. If overdriving of the electrical or acoustic part of the receiver occurs at certain frequencies, then a lower output level must be used. The value of this level is to be stated with the results.

Sound pressure as a function of direction is measured with the microphone at a constant distance of 1 or 2 m as indicated in **6.2**, from the centre point of the picture screen. The angle is measured from the optical axis of the picture tube. The direction is varied horizontally and vertically. The measurements shall be carried out at various frequencies, for instance, 125 Hz, 500 Hz, 1 kHz and 4 kHz.

7.3 Presentation of Results — For each audio-frequency, the polar diagram in the given plane of rotation is indicated. For this purpose, polar co-ordinate paper should be used indicating the sound pressure in decibels as a radial vector and the angle between the microphone direction and the optical axis of the picture tube shown as the vector angle. The scale of the radial vectors, indicating the sound pressure, is to be indicated in decibels above the level on the reference axis; thus the lower levels of sound pressure will occur as negative values of decibels. For this reason, the scale must be so chosen that the centre point of the diagram represents a lower level of the sound than the lowest measured value. Such angles seen from the receiver in an upward direction or towards the right shall be indicated as positive angles. Similarly, angles downwards or towards the left shall be indicated as negative angles. An example of such a polar diagram is shown in Fig. 2.

8. ELECTRICAL AUDIO-FREQUENCY RESPONSE CHARACTERISTIC

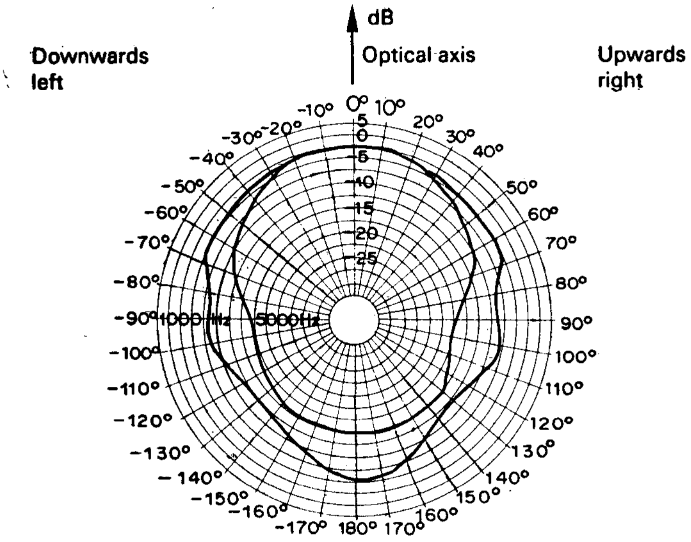
8.1 Definition — The electrical audio-frequency response characteristic of a receiver represents the relative power level of the audio-frequency electrical output signal of the receiver for a constant level of the audio-frequency modulating signal as a function of the applied audio-frequency.

8.2 Method of Measurement — The receiver is provided with a radio-frequency input signal and is tuned as described in **4.1**. Tone controls are placed in the normal position. The volume control is so adjusted that at an audio-modulation frequency of 1 000 Hz, and a modulation factor of 30 percent, the standard output power is obtained. If the volume control is physiologically weighted (tone compensated), it shall be set for minimum tone compensation effect and the required output power obtained by adjusting the modulation input level. If overloading of any part of the receiver, including the output transducers, occurs at any frequency within the range of measurements, a suitable lower output power level shall be chosen, the value of this level being given with the results.

The audio-frequency is varied within the desired audio-frequency range at a constant input level.

The output power level is determined as a function of frequency by measuring the voltage across the audio-frequency substitute load, and it shall be expressed in decibels with reference to the level of the output power at the reference frequency of 1000 Hz.

If the television system calls for the pre-emphasis of the sound signal, the test signal shall be applied after passing through the appropriate pre-emphasis network. In such cases, the low-frequency modulation factor shall be reduced to prevent the modulation factor at the highest



Input signal level: – 50 dB(mW)
Television channel: 3
Modulation factor: 30%
Electrical output power: 50 dB

Sound pressure at 0°: 0.10 Pa
Curve 1: 1 000 Hz
Curve 2: 5 000 Hz

FIG. 2 EXAMPLE OF ACOUSTIC POLAR DIAGRAM

measurement frequency from exceeding 50 percent.

If several output circuits are incorporated in a receiver, for example, for multiple loudspeakers, headphone or transmission line connection, etc, the relevant output voltages may be measured simultaneously.

8.3 Presentation of Results — Curves showing the electrical audio-frequency response characteristics are plotted with the frequency as the abscissae on a logarithmic scale, and the output level, expressed in decibels with respect to that at the reference frequency, as the ordinates on a linear scale, for a fixed value of the modulation factor.

9. ELECTRICAL AUDIO-FREQUENCY RESPONSE CHARACTERISTICS OF TONE CONTROLS

9.1 Definition — The frequency response characteristics of a tone control are given by a family of curves representing the difference between the levels of the audio-frequency electrical output power for various adjustments of the tone control, and the level of the audio-frequency electrical output power for normal position of the tone controls as a function of the audio-frequency.

9.2 Method of Measurement — The measurement according to **8.2** is repeated for various adjustments of the tone controls, including at least their extreme positions. The output levels of these measurements are compared with the results obtained from the measurement according to **8.2**. The differences of the levels, expressed in decibels, at various frequencies, shall be noted. A clear statement of the relevant adjustments of the tone controls shall be included in the results.

9.3 Presentation of Results — Curve showing the electrical audio-frequency response characteristics of tone controls are plotted with the frequency as the abscissa on a logarithmic scale, and the level difference, expressed in decibels, as the ordinate on a linear scale.

10. ELECTRICAL AUDIO-FREQUENCY RESPONSE CHARACTERISTICS OF LOUDNESS CONTROLS

10.1 Definition — The audio-frequency response characteristics of loudness controls (tone compensated or physiological volume controls) are given by a family of curves representing the difference between the levels of the audio-frequency electrical output power for specified adjustments of the loudness control and the level of the audio-frequency output power with the loudness control at maximum, as a function of the audio-frequency of the modulating signal, the specified adjustment of the loudness control being the parameter.

10.2 Method of Measurement — The measurement, in accordance with **8.2**, is repeated for at least three other positions of the loudness control evenly spaced over its range of operation. The output levels are compared with the results from the measurement in accordance with **8.2**. The differences between the levels, expressed in decibels, at various frequencies, shall be noted. A clear statement of the relevant adjustments of the loudness control shall be included in the results.

10.3 Presentation of Results — Curve showing the output level differences as a function of audio-frequency are plotted with the frequency as the abscissa on a logarithmic scale, and the level difference, expressed in decibels as the ordinate on a linear scale, with the relevant adjustment of the loudness control as parameter.

11. VOLUME CONTROL CHARACTERISTIC

11.1 Definition — The volume control characteristic is the curve representing the output power as a function of the position of the volume control for a constant modulation factor or set of modulation factors. The maximum setting indicates the available audio-frequency gain and the minimum setting, the residual audio gain.

11.2 Method of Measurement — The receiver is provided with a radio-frequency input signal and is tuned as described in **4.1**. Tone controls are placed in the normal position and the volume control set at maximum. The modulation factor is adjusted such that with an audio-modulation frequency of 1 000 Hz and output equal to the maximum useful electrical output power is obtained.

The adjustment of the volume control is then varied stepwise and the corresponding output power level determined. If necessary, the modulation factor may be increased up to a maximum of 30 percent at certain points as the volume control setting is reduced in order to provide a reliably measurable output power, these points being noted for inclusion in the results.

11.3 Presentation of Results — The volume control characteristic is plotted with the volume control adjusted in degrees or millimetres as the abscissa on a scale, the minimum position being the reference point. The output power is expressed in dB (mW) on a linear vertical scale, the points corresponding to a change in modulation factor being shown.

12. AUDIO FREQUENCY NON-LINEARITY DISTORTION

12.1 The audio-frequency non-linearity distortion, which is the distortion in the audio-frequency spectrum caused by non-linear elements is dealt with in **12.1** and **12.2**.

This type of distortion depends on so many details, both of design and operational conditions, that it is not possible to specify any complete set of measuring procedures.

As part of the audible distortion is caused by the loudspeaker itself, it would be more correct to measure the distortion acoustically. Such acoustic measurements generally involve considerable difficulty and the measurements described below are therefore restricted to the electrical output power.

Hum and scanning and other similar interference voltages shall not be included in the calculation or the measurement of harmonic distortion; filters shall be used, if necessary.

12.2 Measurements in Case of More Than One Set of Output Terminals — If applicable, the measurements shall be repeated at all output terminals, if more than one set of output terminals is provided. If two or more sets of output terminals are used simultaneously, each of these shall be connected to a relevant substitute load (*see* **5.2**) during these measurements.

13. DISTORTION IN THE PRESENCE OF A SINGLE SIGNAL, HARMONIC DISTORTION

13.1 Introduction — When the audio-frequency modulating signal is purely sinusoidal, distortion manifests itself through the appearance of additional sinusoidal components of the output power at frequencies which are harmonically related to the frequency of the applied audio-frequency input signal and is generally described by 'harmonic distortion'.

The degree of non-linearity distortion of a receiver is determined by measuring the harmonic content of the voltage across the output transducer or the audio-frequency substitute load, whichever is applicable, for example, with a wave analyzer or with a distortion meter (harmonic distortion analyzer of the fundamental-suppression type), from which the total degree of distortion can be read directly.

Warning — In case of Cayss B amplifiers, switching transients may occur which can be checked by the use of an oscilloscope. In any case, it is advisable to extend the measurements with a wave analyzer well beyond the upper limit of the audio-frequency range.

For distortion values up to 10 percent, the formula may be simplified to:

$$\frac{\sqrt{A_2^2 + A_3^2 + A_4^2 + \ldots}}{A_1} \times 100 \text{ percent}$$

where

A_1, A_2, A_3, etc, are the voltage values of the fundamental and the individual harmonics present in the output circuit.

13.2 Method of Measurement

13.2.1 *Measurement of Distortion as a Function of Output Power* — The receiver is provided with a radio-frequency input signal and is tuned as described in **4.1**. Tone controls are placed in the normal position. The audio-frequency modulating signal, at a frequency of 1 000 Hz, is adjusted for a 30 percent modulation factor.

The setting of the volume control is varied and the harmonic distortion measured as a function of the audio-frequency output power. If required, the measurement may be repeated at other modulating frequencies.

For receivers incorporating audio-frequency amplifiers using transistors and having output stages operating in Class B distortion measurements shall include the region of very small output powers since the non-linearity distortion may noticeably increase for decreasing values of the output power.

13.2.2 *Measurement of Distortion as a Function of Modulation Factor* — The receiver is provided with a radio-frequency input signal and is tuned as described in **4.1**. Tone controls are placed in the normal position. The audio-frequency modulating signal, at a frequency of 1 000 Hz, is adjusted for a 30 percent modulation factor. The volume control is adjusted to obtain a standard output power for which the distortion is negligible.

The audio-frequency signal modulation factor is varied up to the maximum value for the system in use, the volume control being adjusted in each case to obtain the standard output power chosen, and the harmonic distortion is measured.

13.3 Presentation of Results — Curves showing audio-frequency distortion at a single audio-frequency as a function of the output power are plotted with the output power in watts as the abscissa on a logarithmic scale, and the distortion as the ordinate on a linear scale.

Curves showing audio-frequency distortion at a function of the audio-frequency with a constant output power are plotted with the frequency as the abscissa on a logarithmic scale, and the distortion as the ordinate on a linear scale.

Curves showing audio-frequency distortion as a function of modulation factor are plotted with the modulation factor as the abscissa on a linear scale and distortion as the ordinate on a linear scale.

14. SIGNAL-TO-NOISE RATIO DUE TO PICTURE SIGNAL CROSS-MODULATION

14.1 Introduction — Receivers for television systems using frequency modulated sound commonly employ the intercarrier technique. Under some conditions, cross-modulation of components of the picture signal into the sound signal can occur. Due to the complex manner in which this cross-modulation can arise, the subjective effect upon a listener is expressed as a signal-to-noise ratio. The greatest interference tends to occur when the picture signal contains components of high modulation depth at sub-harmonics of the intercarrier frequency. When carrying out these measurements, care shall be taken that the signal source does not introduce cross-modulation between picture and sound signals. Since there are receiver designs that employ forms of multiplicative demodulation for the picture signal, these precautions shall include freedom of picture-signal-dependent phase shift of the radio-frequency carrier.

14.2 Method of Measurement — The receiver is provided with a radio-frequency input signal and is tuned as described in **4.1**. Tone controls are placed in the normal position. An audio-modulating signal with a frequency equal to the standard reference frequency (1 000 Hz) is applied at a level giving the maximum system frequency deviation. The volume control is then adjusted to provide the standard output power. The output voltage level at 1 000 Hz is the reference level for the signal-to-noise ratio measurement. The sound signal modulation is switched off and, instead of the test pattern, a composite signal having sinusoidal picture modulation is applied having an average video modulation level of 50 percent. This signal has a level causing it to extend from black level to white level and is adjustable in frequency from 1 MHz to the upper limit of the video passband. Particular care is to be taken to examine the regions close to the sub-harmonic of the intercarrier frequency. It is recommended that the audio-frequency output voltage throughout the range of picture modulation frequencies is measured using a quasi-peak indicating instrument with a weighted frequency response characteristic as defined below. The time response of the measuring instrument is given in Table 2.

TABLE 2 TIME RESPONSE OF THE MEASURING INSTRUMENT

Sl No.	Pulse Duration (ms)*	10	20	50	100	200
i)	Percentage of steady signal reading	48	52	59	68	80
ii)	Limit values, percent					
	lower limit	41	44	50	58	68
	upper limit	55	60	68	78	92

*The pulse consists of a burst of an ac voltage having a frequency of 5 000 Hz and an amplitude corresponding to two-thirds of the full-scale indication of the measuring instrument. The indication is that obtained from the application of a single pulse. The dynamic characteristics of the measuring instrument are such that it complies with the test given in **14.2.1**.

14.2.1 A series of bursts of 5 000 Hz having a repetition frequency of 30 Hz and a duration of 5 ms is applied to the instrument. The amplitude of the bursts shall correspond to approximately two-thirds of the full-scale indication. The indication shall be 70 to 90 percent of the value corresponding to a steady signal of the same amplitude. This test procedure applies to all ranges. The overload capacity of any amplifier preceding the rectification should be at least 20 dB relative to the maximum scale indication. This requirement applies to all ranges.

Care shall be taken that errors are not introduced by the presence of hum voltages derived from the mains supply or scanning circuits.

Note 1 — If the level of interference generated by the signal extending from black level to white level is so great that at certain frequencies overloading of the audio stages takes place, the measurements shall be carried out with the sinewave modulation extending over a lower range. This may, for instance, be 25 to 75 percent of the white level. The range of levels used shall be stated with the results.

Note 2 — Since a quasi-peak meter is used, the numerical value of signal-to-noise ratio may differ from that obtained with other forms of meter.

14.3 Presentation of Results — The signal-to-noise ratio is expressed in decibels relative to the output at 1 000 Hz sinewave modulation with the maximum system frequency deviation. The results are shown graphically with the signal-to-noise ratio in decibels as the ordinate and the picture modulation frequency as the abscissa.

15. AMPLITUDE MODULATION SUPPRESSION RATIO

15.1 Definition — The generation of the inter-carrier sound signal from the picture and sound signals gives rise to an intercarrier signals in which the wanted frequency modulation is accompanied by some measure of amplitude modulation. The amplitude modulation suppression ratio of a receiver is a figure indicating the capability of the receiver to suppress amplitude modulation and inter-modulaion components in the audio output signal when a simultaneously amplitude and frequency modulated signal is applied to the input.

15.2 Method of Measurement — The receiver is provided with a radio-frequency input signal and is tuned as described in **4.1**. The tone controls are placed in the normal position. An audio-modulating signal with a frequency of 400 Hz is applied at a level giving the maximum system frequency deviation. The volume control is then adjusted such that while providing an output signal power that may be readily measured, no overloading of the audio-frequency section of the receiver takes place. The audio-frequency output power is measured according to **5.3** but with the possibility of interposing one of a pair of bandpass filters between the load and the measuring instrument shown in Fig. 3. One filter passes the frequency band between 350 and 450 Hz and the other between 450 Hz and 15 kHz. The test pattern is removed and the picture modulation set at black level. The audio-frequency output power is measured with the narrow-band filter in circuit. This output power is designated P_1. The power measurement is repeated with the wideband filter in circuit indicating the output power of the harmonics of the 400 Hz modulation signal. This is designated as P_2. Maintaining the 400 Hz frequency modulation of the sound carrier, it is then additionally amplitude-modulated to a modulation factor of 30 percent with a frequency of 1 000 Hz. The output power is then measured with the wideband filter in circuit and this power is designated as P_3. The amplitude modulation suppression ratio is given by the formula:

$$R = \frac{P_1}{P_3 - P_2}$$

Measurements shall also be carried out with square-wave modulation with a modulation factor of 90 percent. Additional measurements may be carried out with other values of amplitude modulation, over a range of input signal levels, and ratios of sound to picture signal level.

Care shall be taken that errors are not introduced by a presence of hum voltages derived from the main supply or scanning circuits. In order that measurement errors are not introduced, it shall be established that negligible crosstalk of components derived from the picture signal when the picture modulation is set to black level is present in the audio output.

15.3 Presentation of Results — The amplitude modulation suppression ratios for the various measurement conditions derived from the formula given in **15.2** are expressed in decibels.

16. AMPLITUDE-MODULATED SOUND RECEPTION SIGNAL-TO-NOISE RATIO DUE TO PICTURE SIGNAL INTERFERENCE

16.1 Introduction — Interference derived from the picture signal can occur in the audio-frequency

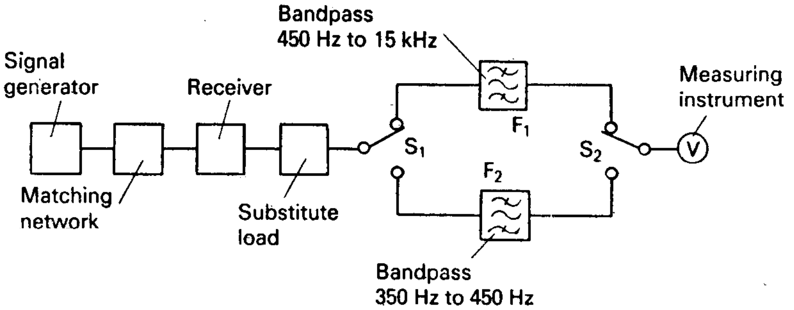


Fig. 3 Measurement of Amplitude Modulation Suppression Ratio

output signal of receivers for television systems using amplitude-modulated sound. Due to the complex manner in which this interference can arise, the subjective effect upon a listener is expressed as a signal-to-noise ratio. The greatest interference tends to occur when the picture signal contains components of high modulation depth in the audio-frequency band and when the picture signal contains high video-frequency components that are themselves interrupted at an audio-frequency.

16.2 Method of Measurement — The receiver is provided with a radio-frequency input signal and is tuned as described in **4.1**. The tone controls are placed in the normal position. An audio modulating signal with a frequency equal to the standard reference frequency (1 000 Hz) is applied at a level giving a modulation factor of 30 percent. The volume control is then adjusted to provide the standard output power. The output voltage level at 1 000 Hz is the reference level for the signal-to-noise ratio measurements. The sound signal modulation is switched off and, instead of the test pattern, a sinusoidal picture modulation is applied having an average picture modulation level of 50 percent. This signal has a level causing it to extend from black level to white level and is adjustable in frequency over a complete audio-frequency range. The audio output voltage throughout the range of picture modulation frequencies is measured using a quasi-peak indicating instrument with a weighted frequency response characteristic as defined in **14.2**.

The measurements may be repeated using a sinusoidal signal near the high-frequency end of the video-frequency band, for instance, the colour sub-carrier, that is itself modulated 100 percent by the range of audio-frequency signals. The level of the audio-modulated picture signal should be arranged to extend from black level to white level and have an average picture modulation level of 50 percent.

16.3 Presentation of Results — The signal-to-noise ratio is expressed in decibels relative to the output at 1 000 Hz sinewave modulation with a modulation factor of 30 percent. The results show the signal-to-noise ratio graphically in decibels as the ordinates with the audio-frequency picture modulation as the abscissa, the type of picture modulation being indicated as either direct audio-frequency modulation of the picture carrier or audio-frequency modulation of a video-frequency signal.

17. HUM

17.1 Definition — Components in the audio-frequency output signal that are derived from frequencies present in the power input to the receiver or that are related to the scanning frequencies or harmonics thereof, are designated hum. Although components of the picture signal can give rise to similar disturbance, these are not considered here (*see* **14, 15** and **16**) but the effect of audio-frequency signalling voltages that may be present on the mains supply, are included.

17.2 Method of Measurement — For receivers operating from alternating current mains, measurements are carried out by providing the receiver with power from a pure sinusoidal source (having an impedance less than 0·5 percent of the load impedance) or with such a sinusoidal source to which an audio-frequency of the mains voltage in use and the frequency varied over the entire audio-frequency range. For receivers operating from dc supplies, measurements are to be made with the receiver operating from a pure dc source upon which is superimposed a sinusoidal audio-frequency voltage obtained from a source of negligible impedance. The effective rms value of the audio-frequency component is to be set at 2 percent of the dc supply and the frequency varied over the complete audio-frequency range. The hum components are determined by measurement of the voltage across the audio-frequency substitute load. The power supplied to the loudspeaker is calculated for each measurement from the measured value of voltage and the load impedance. During the measurements, the receiver shall be connected to earth when an earth connection is provided. The measurement circuits are shown in Fig. 4 and 5. In both cases the switch S_1 shall be placed in the position that gives rise to the greatest hum, the switch position being shown with the results.

With the switch S_2, the audio-frequency input can be changed from the symmetric mode

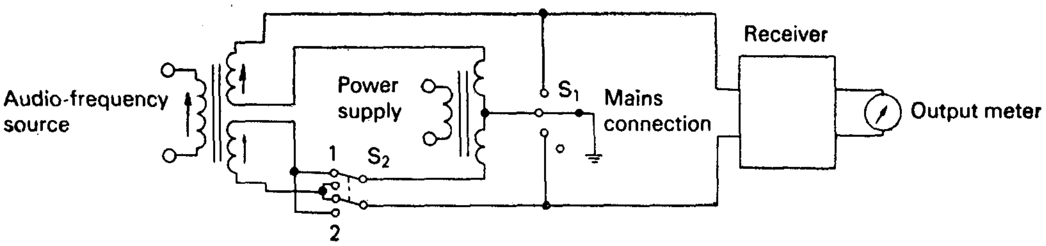


FIG. 4 CIRCUIT ARRANGEMENT FOR MEASURING HUM INTRODUCED FROM ac MAINS

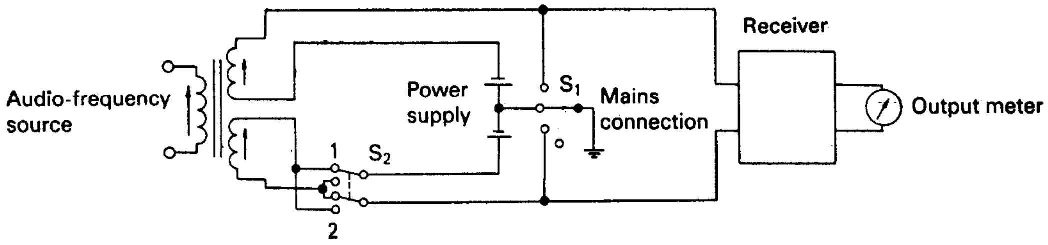


FIG. 5 CIRCUIT ARRANGEMENT FOR MEASURING HUM INTRODUCED FROM dc MAINS

(position 1) to the asymmetric mode (position 2).

When measurements are made with a pure sinusoidal mains supply or a pure dc mains supply, all significant hum components are to be measured. When measurements are made with a superimposed audio-frequency voltage, only the components at this frequency are to be measured.

The acoustic properties of the receiver and the physiological properties of the ear must be taken into account when interpreting the measurement results.

17.3 Measurement of Hum as a Function of Input Signal Level — The receiver is provided with a radio-frequency input signal and is tuned as described in **4.1**. Tone controls are placed in the normal position. An audio-modulating signal with a frequency equal to the standard reference frequency (1 000 Hz) is applied at a level giving maximum system frequency deviation for systems using frequency modulated sound, or a modulation factor of 30 percent for systems using amplitude modulated sound. The volume control is adjusted to provide maximum useful electrical output power. The picture modulation is set at black level and the audio modulation removed. Measurements of hum are made over a range of input signal levels, care being taken that inaccuracy does not result owing to background noise effects or cross-modulation.

17.4 Hum as a Function of Volume Control Adjustment — The measurement conditions are those as described in **17.3**, the input signal level being such that background noise effects do not influence the measurements. Hum for various conditions of mains supply (*see* **17.2**) is measured at a suitable number of settings of the volume control.

17.5 Hum as a Function of Tone Control Adjustment — The measurement conditions are those as described in **17.3**, the input signal level being such that background noise effects do not influence the measurements. The hum for various conditions of mains supply (*see* **17.2**) is then measured over a suitable number of settings of the tone control.

17.6 Presentation of Results — For all measurement conditions, the results may be presented graphically with the output power of the hum component as the ordinates and the frequency or control setting as the abscissae. When the measurements relate to pure sinusoidal mains supplies, pure dc supplies or components derived from the scanning circuits, the most significant hum components may be indicated on the graph by vertical lines. The output power shall use a linear scale in dB (mW) and the frequency scale shall be logarithmic.

18. SIGNAL-TO-NOISE RATIO

18.1 Definition — The signal-to-noise ratio is the ratio of the output power of the signal to that of the background noise expressed in decibels. Frequencies below 300 Hz and above 15 kHz are eliminated for these measurements by means of a bandpass filter. The effect of this filter is to eliminate hum and spurious components while not influencing the measurements.

18.2 Method of Measurement — The measurement set-up is shown in Fig. 6. In the lower

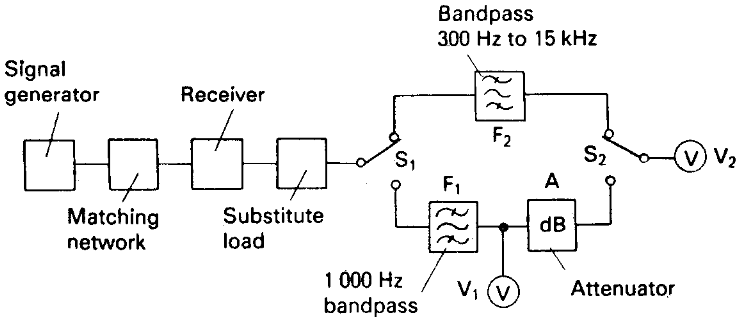


FIG. 6 MEASUREMENT OF SIGNAL-TO-NOISE RATIO

signal path a narrow-band 1 000 Hz filter F_1 and an attenuator A, calibrated in decibels are included. The output meters V_1 and V_2 are given the response and frequency characteristic weighting as described in **14.2**. In the upper signal path, the bandpass filter F_2 with a bandpass between 300 Hz and 15 kHz is included. The receiver is provided with a radio-frequency input signal and is tuned as described in **4.1**. The tone controls are placed in the normal position. The picture modulation is set at black level and an audio-frequency modulating signal with a frequency of 1 000 Hz is applied at a level giving a modulation factor of 30 percent. By means of the volume control, the output power indicated on the output power meter V_1 is set to a suitable value with the signal passing through the lower path.

The 1 000 Hz audio modulation is switched off, the signal is switched to the upper path and the noise output indication of the output meter V_2 noted. The signal is then passed again through the lower signal path and the calibrated attenuator adjusted such that, with the 1 000 Hz audio modulation restored, the meter indicates the same values as in the case of the noise measurement. The adjustment of the attenuator thus gives a direct indication of the signal-to-noise ratio.

18.3 Presentation of Results — The signal-to-noise ratio (weighted) is presented graphically in decibels as the ordinate on a linear scale with the input signal level in dB (mW) as the abscissa, also on a linear scale.

19. NOISE LIMITED SENSITIVITY

19.1 Definition — The noise limited sensitivity is the smallest input signal level of the chosen television channel frequency that provides a given value of signal-to-noise ratio in the sound output.

19.2 Method of Measurement — The method of measurement is as described in **18.2**.

19.3 Presentation of Results — The noise limited sensitivity for a constant signal-to-noise ratio (weighted) in the sound output is presented graphically as a function of the frequency to which the receiver is tuned, with the picture carrier frequency on a linear scale as the abscissa and the noise limited sensitivity in dB (mW) on a linear scale as the ordinate. The channel numbers may be included in addition to the picture carrier frequency.

20. GAIN LIMITED SENSITIVITY

20.1 Definition — The gain limited sensitivity is the smallest input signal level of the chosen television channel frequency required to produce the standard output power (*see* **5.4**) with the volume control set to maximum and the sound carrier having a modulation factor of 30 percent with a 1 000 Hz tone modulation.

20.2 Method of Measurement — The method of measurement is that of **18.2**, using the measurements to be carried out with the signal passing through the lower signal path (*see* Fig. 6).

20.3 Presentation of Results — The results are presented graphically with the picture carrier frequency on a linear scale as the abscissa and the signal level in dB (mW) on a linear scale as the ordinate. The channel number may be included in addition to the picture carrier frequency.

NOTE — The sensitivity of the sound section shall be presented together with the sensitivity of the picture section of the receiver.

21. DEVIATION SENSITIVITY

21.1 Definition — The deviation sensitivity of a receiver intended for use with a television system having frequency modulated round is the smallest deviation of the sound carrier of a television signal with a 1 000 Hz tone modulation that gives rise to the standard output power, the signal level being such that background noise effects do not influence the result.

21.2 Method of Measurement — The receiver is provided with radio-frequency input signal at a level such that background noise effects do not influence the results and is tuned as described in **4.1**. The tone controls are placed in the normal position. The volume control is set to maximum. An audio modulating signal with a frequency equal to the standard reference frequency (1 000 Hz) is applied and the level adjusted to give standard output power. The resultant modulation factors measured using a suitable deviation measuring instrument.

21.3 Presentation of Results — The measured value of the deviation is stated together with the level chosen as the standard output power.

22. INTERFERENCE

22.1 Selectivity

22.1.1 *Definition* — The selectivity of a television receiver is its ability to reject from the signals impressed on its input terminals those signals that have frequencies outside the television channel to which the receiver is tuned.

The pass band characteristics of the sound circuits of a receiver measured by a single-signal generator method give only limited information on its ability to reject unwanted signals at nearby frequencies. Cross modulation and demodulation effects and second order effects arising from the presence of both the sound and vision carrier cannot be measured in this way. A two signal method comprising a 'Television test signal'

(the desired signal) and a separate FM signal generator (the undesired signal) is used.

22.1.2 *The Two-Signal Method af Measurement* — The desired and undesired signals are applied to the receiver. The desired signal is adjusted to the level at which the measurements are to be taken. The receiver is tuned to the desired signal for maximum audio-frequency output power. The desired signal is then modulated 30 percent at 1 000 Hz, the level of the undesired signal being adjusted to zero. The output power is adjusted by means of the volume control at such a fixed value that no part of the receiver is overloaded. The modulation of the desired signal is then switched off and the level of the undesired signal, modulated 30 percent at 1 000 Hz is adjusted until an output power is obtained 30 dB below the output power obtained with the modulated desired signal.

Care should be taken that no whistle, hum, or noise affects the measurement. The use of a 1 000 Hz filter will generally be necessary.

When the unmodulated undesired signal affects the output power of the modulated signal, the output power should be re-adjusted by means of the volume control to the fixed level mentioned above.

In some receivers there may be discontinuities in the relation between the output power and the level or frequency of the interfering signal, in which case the procedure specified may be difficult to apply. A statement should be added to the result if such discontinuities are observed.

22.1.2.1 *Graphic representation* — The results of the measurements are plotted as curves with the input signal level of the desired signal as parameter. The frequency difference in KHz is plotted as abscissa on a linear scale and the ratio of the level of the undesired signal to that of the desired signal as ordinate on a linear scale in dB.

An example is given in Fig. 7.

22.1.3 Alternatively, in place of the Television Test signal, a picture signal generator and a sound signal generator with the correct inter-carrier separation and relative signal levels for the desired signal and a separate FM signal generator for the undesired signal, all suitably connected through an artificial aerial network can be used.

22.2 Spurious Responses

22.2.1 In general, the image and intermediate frequency ratios will be determined by the radio-frequency circuit ahead of the frequency changer and will therefore be approximately the same as for the vision receiver. In some cases, however, an intermediate-frequency rejector circuit may affect the vision and sound channel differently and in such a case separate measurement of the intermediate-frequency ratio for the sound channel should be made. Other spurious responses of the sound channel will be recorded in the tests made according to 6 of IS : 4545 (Part 6)-1983*.

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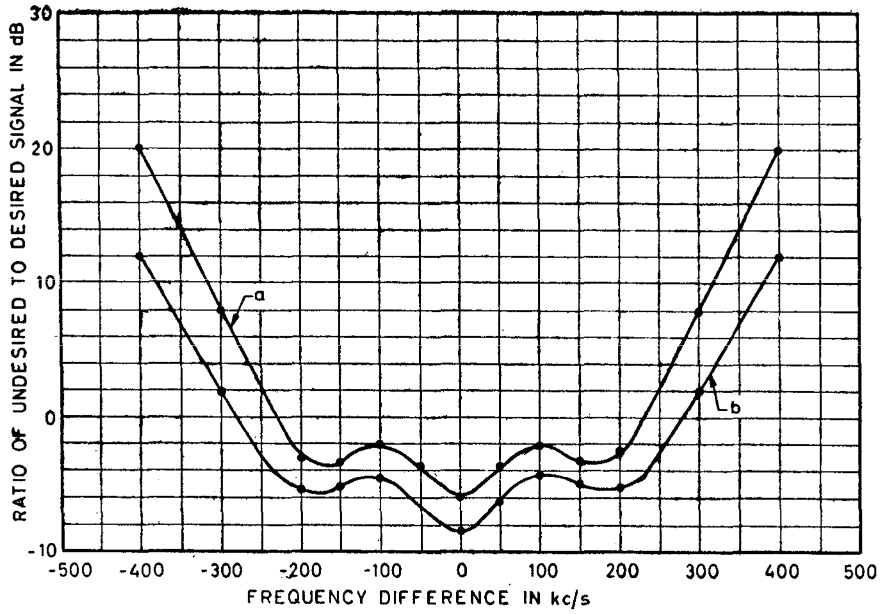
*Methods of measurement on receivers for television broadcast transmissions: Part 6 Selectivity and response to undesired signals (*first revision*).



Measuring frequency 187·75 Mc/s.

a = Sound input signal level : −50 dB (mW)
b = Sound input signal level : −80 dB (mW)

FIG. 7 TWO-SIGNAL SELECTIVITY CURVES

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